Supporting Information

Distribution and Risk Assessment of Organophosphate Esters in Agricultural Soils and Plants in the Coastal Areas of South China

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Text S1 The method of soil sample extraction and detection of TOC and pH in soil.

Plants: After adding 20 mL of the extractant mixture to the glass centrifuge tube with the plant sample, shaken well. The sample was then placed in the ultrasonic extraction system for 20 min, followed by centrifugation at 4000 rpm for 10 min. After centrifugation, the supernatant was transferred to the chicken heart bottle. The ultrasonic extraction and centrifugation operation was repeated three times, and three supernatants were combined into the chicken heart bottle. The supernatant in the flask was evaporated to approximately 2 mL using nitrogen and then left to purify. A glass column packed with 4 cm of neutral silica gel, and 1 cm of anhydrous sodium sulfate, was used for sample purification. Activated the column with 10 mL of n-hexane and discarded it. Connected the commercialized Graphitized carbon black (GCB) column (activated with 6 mL of acetone) to the bottom of the silica gel column, loaded the sample of nitrogen-blown, and washed the combined column with 20 mL of acetone. When the rinsing solution was about to flow out, replaced the waste liquid bottle with a chicken heart bottle. Blew the solution in the chicken heart bottle to near dryness. The volume was then adjusted by adding 1 mL hexane to the flask and shaking well, which was sealed and stored for detection.

Soil: Weighed 1 g soil sample and placed into a 30 mL glass centrifuge tube. The extractant was a hexane: dichloromethane: acetone (2:2:1; v/v) mixture. Subsequently, 10 mL of the extractant mixture was added to the glass centrifuge tube with the soil sample, and shaken well. The sample was placed in the ultrasonic extraction system: the time was set to 20 min. The centrifugation setting was 2000 r/min, 10 min. The supernatant was transferred to the chicken heart bottle at the end of centrifugation. The above ultrasonic extraction and centrifugation operation was repeated three times, and three supernatants were combined into the chicken heart bottle. The flask containing the supernatant was nitrogen blown to near dryness, and the volume was fixed by adding hexane to the flask to a total volume of 1 mL, and shaken well, which was sealed and stored at 4℃ for detection.

TOC and pH: Soil pH was measured using a pH meter (Inesa, Shanghai, China) with a soil/water ratio of 1:2.5. Total organic carbon (TOC) was measured using an Elementar Vavio EL III elemental analyzer (Hanau, Germany).

Table S1. Details of the 37 sampling sites.

Sampling location	East Longitude	Northern Latitude
CZX	117.100806	23.572944
FCGS	108.515856	21.599694
FCGL	108.212319	21.506575
MMT	110.951478	21.563847
MMN	111.049783	21.463131
MMJ	111.262819	21.423122
MML	111.419615	21.540649
MMY	111.184644	21.500889
QZD	118.979964	25.001342
QZM	118.950714	25.158578
QZB	118.760797	24.766167

XMZ	118.020906	24.450444
XML	118.193719	24.574706
YJS	111.681011	21.595306
YJL	111.822364	21.713825
ZJT	110.409367	21.004358
ZJB	110.375092	21.169489
ZJJ	110.897219	21.402325
ZZT	117.270911	23.635269
ZZB	117.610719	23.795119
ZZS	117.894083	24.079042
ZZZ	118.097258	24.257917
SWN	115.420097	22.694058
BHX	109.712433	21.481092
STB	116.780892	23.367864
JYD	116.439492	22.949333
GXQZZ	108.734553	21.637219
DGF	113.577308	22.88475
JMC	113.010436	21.981544
ZHG	113.237053	21.922653
ZSL	113.550114	22.491089
HZX	114.66896	22.77592
GZX	113.566014	22.718153
GZT	113.496656	22.942033
GZN	113.504078	23.07355
SZM	113.771397	22.741106
SZX	114.327478	22.607647

Note: Guangdong Province included Chaozhou (CZ), Maoming (MM), Yangjiang (YJ), Zhanjiang (ZJ), Shanwei (SW), Shantou (ST), Jieyang (JY), Dongguan (DG), Jiangmen (JM), Zhuhai (ZH), Zhongshan (ZS), Huizhou (HZ), Guangzhou (GZ), Shenzhen (SZ); Guangxi Zhuang Autonomous Region included Fangchenggang (FCG), Beihai (BH), and Qinzhou (GXQZ); and Fujian Province included Quanzhou (QZ), Xiamen (XM), and Zhangzhou (ZZ).

Table S2 GS-MS/MS parameter of OPEs

Acronym	CAS No.	Chemical formula	Mol. Wt.	Quantifier/Qualifier
TCEP	115-96-8	C6H12Cl3O4P	285.5	249/143
TDCIPP	13674-87-8	C9H15Cl6O4P	430.9	191/381
TPHP	115-86-6	C18H15O4P	326.3	170/228
EHDPHP	1241-94-7	C20H27O4P	362.4	251/170
TCPP	6145-73-9	C9H18Cl3O4P	327.5	125/99
ToCP	78-30-8	C21H21O4P	368.37	179/165
TpCP	78-32-0	C21H21O4P	368.37	165/243
TmCP	563-04-2	C21H21O4P	368.37	165/198

Table S3. Parameters for calculating PNECsoil, RfD, and SFO of OPEs in soils

OPEs	PNECsoil(ng/g)	RfD (mg/kg/d)	SFO $(mg/kg/d)^{-1}$
TCEP	386[1,2]	7.00E-03[3,4,5]	2.00E-02[3,4,5]
TDCI PP	320[1,2]	2.00E-02[3,4,5]	3.10E-02[3,4,5]
TPHP	130[1,2]	7.00E-02[3,4,5]	-
EHD PP	30.2[1,2]	-	-
TcPP	-	-	-
ToCP	-	-	-
TpCP	-	-	-
TmCP	-	-	-

Note: PNECsoil is the expected concentration of ineffective stress in soil (ng/g dry weight). RfD is the corresponding oral reference dose, mg/kg-day; SFO is the corresponding oral cancer slope factor $(mg/kg-day)^{-1}$.

Table S4 Calculation parameters and values used in the health risk assessment model to evaluate exposure risks of OPEs in soils

parameter	units	Exposure		References
		Children	Adult	
IR	mg/day	50	20	[3,6-9]
EF	day/year	350	350	[3,6-9]
ED	year	6	24	[3,6-9]
BW	kg	29	63	[3,6-9]
AT	Day	2190 (non-carcinogenic) 25550 (carcinogenic)	8760 (non-carcinogenic) 25550 (carcinogenic)	[3,6-9]
HR	m^3/day	7.6	16	[3,6-9]
PEF	m^3/kg	1.4×10^9	1.4×10^9	[3,6-9]
SA	cm^2	2800	5700	[3,6-9]
AF	mg/cm^2	0.2	0.07	[3,6-9]
ABS	unitless	0.1	0.1	[3,6-9]
GIABS	unitless	1	1	[3,6-9]

Note: CDIingest, CDIdermal, and CDIinhale represent the chronic daily intake through feeding, skin contact, and inhalation pathways, respectively, (mg/kg-day); Csoil is the concentration of OPEs in the soil, mg/kg; IR is the soil ingestion rate, mg/day; EF is the exposure frequency, day/year; ED is the exposure cycle, year; ET is the daily exposure time, h/day; BW is the weight, kg; AT is the average exposure time, day; HR is the air intake rate, m^3/day; PEF is the particulate matter emission factor; SA is the surface area of skin exposure,cm^2; AF is a relative skin adhesion factor, mg/cm^2; ABS is a skin absorption factor, no units; CF is the conversion coefficient,10^{-6} kg/mg. GIABS is a gastrointestinal absorption factor, without units; X represents the number of pollutants.

Table S5 Daily consumption (g/day) and body weight (kg) for general Chinese Children and Adult.

parameter	Children	Adult	References
DC	166.2	369.1	[10,11]
BW	29	63	[3,6-9]

Note: EDI: estimate of dietary intake, (ng/kg bw/day), C represents the concentration of OPE in crops (ng/g dry weight), DC is the daily crop consumption of consumers (g/day), BW is the body weight (kg).

Table S6 Estimated Risk quotient (RQ) of different OPEs for soil and total RQ in the coastal areas of South China

Sampling location	TCEP	TDCIPP	TPHP	EHDPP	ΣOPE
CZX	0.238979591	0.696541055	0.071840227	0.152696009	1.160056882
FCGS	0.034016473	0.311417902	0.055894602	0.162166121	0.563495098
FCGL	0.04241979	0.457208664	0.074160865	0.151836685	0.725626003
MMT	0.045015115	0.526625109	0.06162262	0.115211623	0.748474467
MMN	0.033005071	0.260999567	0.107911532	0.128104415	0.530020586
MMJ	0.025830989	0.094764697	0.068885685	0.122152676	0.311634047
MML	0.04337308	0.482391025	0.126702868	0	0.652466973
MMY	0.029072546	0.157715764	0	0	0.186788311
QZD	0.042208216	0.250793137	0.058780735	0.134012379	0.485794467
QZM	0.079026512	0.757063827	0.055607215	0.127022782	1.018720336
QZB	0.058052632	0.223829256	0.075237199	0	0.357119087
XMZ	0.062151634	0.617254481	0.05285294	0	0.732259055
XML	0.052081659	0.768307409	0.057621669	0.122627016	1.000637753
YJS	0.02594447	0.050534561	0.058211131	0	0.134690163
YJL	0.072481089	0.721633021	0.053004272	0.122099263	0.969217645
ZJT	0.033921667	0.384479425	0.060741003	0.189596043	0.668738138
ZJB	0.032419602	0.520466585	0.074047523	0.186648602	0.813582312
ZJJ	0.01306218	0.226912028	0.079349715	0.233744647	0.55306857
ZZT	0.049701595	0.566353476	0.063685837	0.162874788	0.842615696
ZZB	0.098285002	0.43310989	0.05298945	0.147183893	0.731568235
ZZS	0.291244005	0.484868555	0.065080927	0.147944461	0.989137948
ZZZ	0.018322122	0.10761492	0.030453195	0	0.156390236
SWN	0.049993993	0.62243652	0.061073678	0.172469768	0.905973958
BHX	0.037526812	0.091573897	0.051207541	0.159948511	0.340256762
STB	0.030048255	0.37502394	0.063184005	0.787949622	1.256205822
JYD	0.046094393	0.602602872	0.047446706	0.698681097	1.394825069
GXQZZ	0.033610868	0.521385379	0.051290728	0.127609974	0.733896949
DGF	0.010325102	0.09312168	0.050348701	0.117017434	0.270812917
JMC	0.038511831	0.38193769	0.109014428	0.136260418	0.665724368
ZHG	0.401065352	0.49172085	0.034365433	0.114181264	1.0413329

ZSL	0.28762569	0.724661056	0.060675431	0.133634573	1.20659675
HZX	0.085115137	0.523604179	0.03575378	0.114993698	0.759466793
GZX	0.0132741	0.332206666	0.050532428	2.38135931	2.777372503
GZT	0.032784548	0.37618099	0.044400656	0	0.453366194
GZN	0.089663043	0.61059038	0.056671592	0.231086583	0.988011598
SZM	0.069874735	0.621506117	0.105902912	0.134141741	0.931425505
SZX	0.072259081	0.627589636	0.03781831	0	0.737667027
maximum	0.401065352	0.768307409	0.126702868	2.38135931	2.777372503
minimum	0.010325102	0.050534561	0	0	0.134690163
mean	0.073469945	0.435054762	0.061199123	0.208520416	0.778244247

Table S7 The hazard quotient (HQ) for different OPEs with two pathways in soils.

A: The hazard quotient (HQ) of ΣOPE with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total HQ	ingestion	Dermal contact	Total HQ
CZX	4.04E-02	4.53E-02	8.57E-02	7.44E-03	1.49E-02	2.23E-02
FCGS	1.15E-02	1.29E-02	2.44E-02	2.12E-03	4.23E-03	6.35E-03
FCGL	1.62E-02	1.81E-02	3.43E-02	2.98E-03	5.95E-03	8.93E-03
MMT	1.82E-02	2.04E-02	3.86E-02	3.36E-03	6.69E-03	1.00E-02
MMN	1.02E-02	1.15E-02	2.17E-02	1.89E-03	3.76E-03	5.65E-03
MMJ	5.07E-03	5.68E-03	1.08E-02	9.34E-04	1.86E-03	2.80E-03
MML	1.71E-02	1.92E-02	3.63E-02	3.15E-03	6.28E-03	9.43E-03
MMY	6.82E-03	7.64E-03	1.45E-02	1.26E-03	2.51E-03	3.76E-03
QZD	1.07E-02	1.19E-02	2.26E-02	1.96E-03	3.92E-03	5.88E-03
QZM	2.74E-02	3.07E-02	5.81E-02	5.05E-03	1.01E-02	1.51E-02
QZB	1.14E-02	1.28E-02	2.43E-02	2.11E-03	4.20E-03	6.31E-03
XMZ	2.22E-02	2.48E-02	4.70E-02	4.08E-03	8.14E-03	1.22E-02
XML	2.52E-02	2.83E-02	5.35E-02	4.65E-03	9.27E-03	1.39E-02
YJS	3.88E-03	4.35E-03	8.23E-03	7.15E-04	1.43E-03	2.14E-03
YJL	2.59E-02	2.90E-02	5.48E-02	4.76E-03	9.50E-03	1.43E-02
ZJT	1.34E-02	1.51E-02	2.85E-02	2.48E-03	4.94E-03	7.42E-03
ZJB	1.70E-02	1.90E-02	3.59E-02	3.12E-03	6.23E-03	9.35E-03
ZJJ	7.44E-03	8.33E-03	1.58E-02	1.37E-03	2.73E-03	4.10E-03
ZZT	1.97E-02	2.21E-02	4.18E-02	3.63E-03	7.24E-03	1.09E-02
ZZB	2.06E-02	2.30E-02	4.36E-02	3.79E-03	7.56E-03	1.13E-02
ZZS	3.96E-02	4.43E-02	8.39E-02	7.29E-03	1.45E-02	2.18E-02
ZZZ	4.61E-03	5.16E-03	9.77E-03	8.49E-04	1.69E-03	2.54E-03
SWN	2.12E-02	2.38E-02	4.50E-02	3.91E-03	7.79E-03	1.17E-02
BHX	6.00E-03	6.72E-03	1.27E-02	1.10E-03	2.20E-03	3.31E-03
STB	1.29E-02	1.44E-02	2.72E-02	2.37E-03	4.72E-03	7.09E-03
JYD	2.03E-02	2.27E-02	4.30E-02	3.74E-03	7.45E-03	1.12E-02
GXQZZ	1.70E-02	1.91E-02	3.61E-02	3.13E-03	6.25E-03	9.38E-03

DGF	3.56E-03	3.99E-03	7.55E-03	6.55E-04	1.31E-03	1.96E-03
JMC	1.39E-02	1.56E-02	2.96E-02	2.57E-03	5.12E-03	7.69E-03
ZHG	4.97E-02	5.56E-02	1.05E-01	9.15E-03	1.82E-02	2.74E-02
ZSL	4.56E-02	5.10E-02	9.66E-02	8.39E-03	1.67E-02	2.51E-02
HZX	2.17E-02	2.43E-02	4.60E-02	4.00E-03	7.98E-03	1.20E-02
GZX	1.02E-02	1.14E-02	2.15E-02	1.87E-03	3.73E-03	5.60E-03
GZT	1.31E-02	1.46E-02	2.77E-02	2.41E-03	4.80E-03	7.21E-03
GZN	2.45E-02	2.74E-02	5.19E-02	4.51E-03	9.00E-03	1.35E-02
SZM	2.31E-02	2.59E-02	4.90E-02	4.26E-03	8.50E-03	1.28E-02
SZX	2.33E-02	2.61E-02	4.94E-02	4.29E-03	8.56E-03	1.29E-02
maximum	4.97E-02	5.56E-02	1.05E-01	9.15E-03	1.82E-02	2.74E-02
minimum	3.56E-03	3.99E-03	7.55E-03	6.55E-04	1.31E-03	1.96E-03
mean	1.84E-02	2.06E-02	3.90E-02	3.39E-03	6.76E-03	1.01E-02

B: The hazard quotient (HQ) of TCEP with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total HQ	ingestion	Dermal contact	Total HQ
CZX	2.18E-02	2.44E-02	4.62E-02	4.01E-03	8.00E-03	1.20E-02
FCGS	3.10E-03	3.47E-03	6.57E-03	5.71E-04	1.14E-03	1.71E-03
FCGL	3.87E-03	4.33E-03	8.20E-03	7.12E-04	1.42E-03	2.13E-03
MMT	4.10E-03	4.60E-03	8.70E-03	7.56E-04	1.51E-03	2.26E-03
MMN	3.01E-03	3.37E-03	6.38E-03	5.54E-04	1.11E-03	1.66E-03
MMJ	2.35E-03	2.64E-03	4.99E-03	4.34E-04	8.65E-04	1.30E-03
MML	3.95E-03	4.43E-03	8.38E-03	7.28E-04	1.45E-03	2.18E-03
MMY	2.65E-03	2.97E-03	5.62E-03	4.88E-04	9.74E-04	1.46E-03
QZD	3.85E-03	4.31E-03	8.16E-03	7.09E-04	1.41E-03	2.12E-03
QZM	7.20E-03	8.07E-03	1.53E-02	1.33E-03	2.65E-03	3.97E-03
QZB	5.29E-03	5.93E-03	1.12E-02	9.74E-04	1.94E-03	2.92E-03
XMZ	5.67E-03	6.35E-03	1.20E-02	1.04E-03	2.08E-03	3.12E-03
XML	4.75E-03	5.32E-03	1.01E-02	8.74E-04	1.74E-03	2.62E-03
YJS	2.37E-03	2.65E-03	5.01E-03	4.36E-04	8.69E-04	1.30E-03
YJL	6.61E-03	7.40E-03	1.40E-02	1.22E-03	2.43E-03	3.64E-03
ZJT	3.09E-03	3.46E-03	6.56E-03	5.69E-04	1.14E-03	1.71E-03
ZJB	2.96E-03	3.31E-03	6.27E-03	5.44E-04	1.09E-03	1.63E-03
ZJJ	1.19E-03	1.33E-03	2.52E-03	2.19E-04	4.37E-04	6.57E-04
ZZT	4.53E-03	5.07E-03	9.61E-03	8.34E-04	1.66E-03	2.50E-03
ZZB	8.96E-03	1.00E-02	1.90E-02	1.65E-03	3.29E-03	4.94E-03
ZZS	2.66E-02	2.97E-02	5.63E-02	4.89E-03	9.75E-03	1.46E-02
ZZZ	1.67E-03	1.87E-03	3.54E-03	3.08E-04	6.14E-04	9.21E-04
SWN	4.56E-03	5.10E-03	9.66E-03	8.39E-04	1.67E-03	2.51E-03
BHX	3.42E-03	3.83E-03	7.25E-03	6.30E-04	1.26E-03	1.89E-03
STB	2.74E-03	3.07E-03	5.81E-03	5.04E-04	1.01E-03	1.51E-03
JYD	4.20E-03	4.71E-03	8.91E-03	7.74E-04	1.54E-03	2.32E-03

GXQZZ	3.06E-03	3.43E-03	6.50E-03	5.64E-04	1.13E-03	1.69E-03
DGF	9.41E-04	1.05E-03	2.00E-03	1.73E-04	3.46E-04	5.19E-04
JMC	3.51E-03	3.93E-03	7.44E-03	6.46E-04	1.29E-03	1.94E-03
ZHG	3.66E-02	4.10E-02	7.75E-02	6.73E-03	1.34E-02	2.02E-02
ZSL	2.62E-02	2.94E-02	5.56E-02	4.83E-03	9.63E-03	1.45E-02
HZX	7.76E-03	8.69E-03	1.65E-02	1.43E-03	2.85E-03	4.28E-03
GZX	1.21E-03	1.36E-03	2.57E-03	2.23E-04	4.45E-04	6.67E-04
GZT	2.99E-03	3.35E-03	6.34E-03	5.50E-04	1.10E-03	1.65E-03
GZN	8.17E-03	9.16E-03	1.73E-02	1.51E-03	3.00E-03	4.51E-03
SZM	6.37E-03	7.13E-03	1.35E-02	1.17E-03	2.34E-03	3.51E-03
SZX	6.59E-03	7.38E-03	1.40E-02	1.21E-03	2.42E-03	3.63E-03
maximum	3.66E-02	4.10E-02	7.75E-02	6.73E-03	1.34E-02	2.02E-02
minimum	9.41E-04	1.05E-03	2.00E-03	1.73E-04	3.46E-04	5.19E-04
mean	6.70E-03	7.50E-03	1.42E-02	1.23E-03	2.46E-03	3.69E-03

C:The hazard quotient (HQ) of TDCIPP with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total HQ	ingestion	Dermal contact	Total HQ
CZX	1.84E-02	2.06E-02	3.91E-02	3.39E-03	6.77E-03	1.02E-02
FCGS	8.24E-03	9.23E-03	1.75E-02	1.52E-03	3.03E-03	4.54E-03
FCGL	1.21E-02	1.35E-02	2.56E-02	2.23E-03	4.44E-03	6.67E-03
MMT	1.39E-02	1.56E-02	2.95E-02	2.56E-03	5.12E-03	7.68E-03
MMN	6.90E-03	7.73E-03	1.46E-02	1.27E-03	2.54E-03	3.81E-03
MMJ	2.51E-03	2.81E-03	5.31E-03	4.62E-04	9.21E-04	1.38E-03
MML	1.28E-02	1.43E-02	2.71E-02	2.35E-03	4.69E-03	7.04E-03
MMY	4.17E-03	4.67E-03	8.84E-03	7.68E-04	1.53E-03	2.30E-03
QZD	6.63E-03	7.43E-03	1.41E-02	1.22E-03	2.44E-03	3.66E-03
QZM	2.00E-02	2.24E-02	4.25E-02	3.69E-03	7.36E-03	1.10E-02
QZB	5.92E-03	6.63E-03	1.26E-02	1.09E-03	2.17E-03	3.27E-03
XMZ	1.63E-02	1.83E-02	3.46E-02	3.01E-03	6.00E-03	9.00E-03
XML	2.03E-02	2.28E-02	4.31E-02	3.74E-03	7.47E-03	1.12E-02
YJS	1.34E-03	1.50E-03	2.83E-03	2.46E-04	4.91E-04	7.37E-04
YJL	1.91E-02	2.14E-02	4.05E-02	3.51E-03	7.01E-03	1.05E-02
ZJT	1.02E-02	1.14E-02	2.16E-02	1.87E-03	3.74E-03	5.61E-03
ZJB	1.38E-02	1.54E-02	2.92E-02	2.53E-03	5.06E-03	7.59E-03
ZJJ	6.00E-03	6.72E-03	1.27E-02	1.11E-03	2.20E-03	3.31E-03
ZZT	1.50E-02	1.68E-02	3.18E-02	2.76E-03	5.50E-03	8.26E-03
ZZB	1.15E-02	1.28E-02	2.43E-02	2.11E-03	4.21E-03	6.32E-03
ZZS	1.28E-02	1.44E-02	2.72E-02	2.36E-03	4.71E-03	7.07E-03
ZZZ	2.85E-03	3.19E-03	6.03E-03	5.24E-04	1.05E-03	1.57E-03
SWN	1.65E-02	1.84E-02	3.49E-02	3.03E-03	6.05E-03	9.08E-03
BHX	2.42E-03	2.71E-03	5.14E-03	4.46E-04	8.90E-04	1.34E-03
STB	9.92E-03	1.11E-02	2.10E-02	1.83E-03	3.64E-03	5.47E-03

JYD	1.59E-02	1.79E-02	3.38E-02	2.94E-03	5.86E-03	8.79E-03
GXQZZ	1.38E-02	1.54E-02	2.92E-02	2.54E-03	5.07E-03	7.61E-03
DGF	2.46E-03	2.76E-03	5.22E-03	4.54E-04	9.05E-04	1.36E-03
JMC	1.01E-02	1.13E-02	2.14E-02	1.86E-03	3.71E-03	5.57E-03
ZHG	1.30E-02	1.46E-02	2.76E-02	2.39E-03	4.78E-03	7.17E-03
ZSL	1.92E-02	2.15E-02	4.06E-02	3.53E-03	7.04E-03	1.06E-02
HZX	1.39E-02	1.55E-02	2.94E-02	2.55E-03	5.09E-03	7.64E-03
GZX	8.79E-03	9.84E-03	1.86E-02	1.62E-03	3.23E-03	4.85E-03
GZT	9.95E-03	1.11E-02	2.11E-02	1.83E-03	3.66E-03	5.49E-03
GZN	1.62E-02	1.81E-02	3.42E-02	2.97E-03	5.93E-03	8.91E-03
SZM	1.64E-02	1.84E-02	3.49E-02	3.03E-03	6.04E-03	9.07E-03
SZX	1.66E-02	1.86E-02	3.52E-02	3.06E-03	6.10E-03	9.15E-03
maximum	2.03E-02	2.28E-02	4.31E-02	3.74E-03	7.47E-03	1.12E-02
minimum	1.34E-03	1.50E-03	2.83E-03	2.46E-04	4.91E-04	7.37E-04
mean	1.15E-02	1.29E-02	2.44E-02	2.12E-03	4.23E-03	6.35E-03

D:The hazard quotient (HQ) of TPHP with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total HQ	ingestion	Dermal contact	Total HQ
CZX	2.21E-04	2.47E-04	4.68E-04	4.06E-05	8.10253E-05	1.22E-04
FCGS	1.72E-04	1.92E-04	3.64E-04	3.16E-05	6.30409E-05	9.46E-05
FCGL	2.28E-04	2.55E-04	4.83E-04	4.19E-05	8.36426E-05	1.26E-04
MMT	1.89E-04	2.12E-04	4.01E-04	3.48E-05	6.95013E-05	1.04E-04
MMN	3.31E-04	3.71E-04	7.02E-04	6.10E-05	0.000121708	1.83E-04
MMJ	2.12E-04	2.37E-04	4.48E-04	3.89E-05	7.7693E-05	1.17E-04
MML	3.89E-04	4.36E-04	8.25E-04	7.16E-05	0.000142902	2.15E-04
MMY	0	0	0	0	0	0
QZD	1.80E-04	2.02E-04	3.83E-04	3.32E-05	6.62961E-05	9.95E-05
QZM	1.71E-04	1.91E-04	3.62E-04	3.14E-05	6.27168E-05	9.42E-05
QZB	2.31E-04	2.59E-04	4.90E-04	4.25E-05	8.48566E-05	1.27E-04
XMZ	1.62E-04	1.82E-04	3.44E-04	2.99E-05	5.96104E-05	8.95E-05
XML	1.77E-04	1.98E-04	3.75E-04	3.26E-05	6.49888E-05	9.76E-05
YJS	1.79E-04	2.00E-04	3.79E-04	3.29E-05	6.56536E-05	9.86E-05
YJL	1.63E-04	1.82E-04	3.45E-04	3.00E-05	5.97811E-05	8.97E-05
ZJT	1.86E-04	2.09E-04	3.95E-04	3.43E-05	6.8507E-05	1.03E-04
ZJB	2.27E-04	2.55E-04	4.82E-04	4.19E-05	8.35148E-05	1.25E-04
ZJJ	2.44E-04	2.73E-04	5.17E-04	4.49E-05	8.94949E-05	1.34E-04
ZZT	1.96E-04	2.19E-04	4.15E-04	3.60E-05	7.18283E-05	1.08E-04
ZZB	1.63E-04	1.82E-04	3.45E-04	3.00E-05	5.97644E-05	8.97E-05
ZZS	2.00E-04	2.24E-04	4.24E-04	3.68E-05	7.34018E-05	1.10E-04
ZZZ	9.35E-05	1.05E-04	1.98E-04	1.72E-05	3.43468E-05	5.16E-05
SWN	1.88E-04	2.10E-04	3.98E-04	3.45E-05	6.88822E-05	1.03E-04
BHX	1.57E-04	1.76E-04	3.33E-04	2.89E-05	5.77546E-05	8.67E-05

STB	1.94E-04	2.17E-04	4.11E-04	3.57E-05	7.12623E-05	1.07E-04
JYD	1.46E-04	1.63E-04	3.09E-04	2.68E-05	5.3513E-05	8.03E-05
GXQZZ	1.57E-04	1.76E-04	3.34E-04	2.90E-05	5.78484E-05	8.68E-05
DGF	1.55E-04	1.73E-04	3.28E-04	2.85E-05	5.6786E-05	8.53E-05
JMC	3.35E-04	3.75E-04	7.10E-04	6.16E-05	0.000122952	1.85E-04
ZHG	1.06E-04	1.18E-04	2.24E-04	1.94E-05	3.87592E-05	5.82E-05
ZSL	1.86E-04	2.09E-04	3.95E-04	3.43E-05	6.8433E-05	1.03E-04
HZX	1.10E-04	1.23E-04	2.33E-04	2.02E-05	4.0325E-05	6.05E-05
GZX	1.55E-04	1.74E-04	3.29E-04	2.86E-05	5.69932E-05	8.56E-05
GZT	1.36E-04	1.53E-04	2.89E-04	2.51E-05	5.00775E-05	7.52E-05
GZN	1.74E-04	1.95E-04	3.69E-04	3.20E-05	6.39173E-05	9.60E-05
SZM	3.25E-04	3.64E-04	6.89E-04	5.99E-05	0.000119443	1.79E-04
SZX	1.16E-04	1.30E-04	2.46E-04	2.14E-05	4.26535E-05	6.40E-05
maximum	3.89E-04	4.36E-04	8.25E-04	7.16E-05	1.43E-04	2.15E-04
minimum	0	0	0	0	0	0
mean	1.88E-04	2.10E-04	3.98E-04	3.46E-05	6.90E-05	1.04E-04

Table S8 The carcinogenic risk values (CR) for different OPEs with two pathways in soils.

A:The carcinogenic risk values (CR) of TCEP with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total CR	ingestion	Dermal contact	Total CR
CZX	2.61E-07	2.93E-07	5.54E-07	1.93E-07	3.84E-07	5.77E-07
FCGS	3.72E-08	4.17E-08	7.89E-08	2.74E-08	5.47E-08	8.21E-08
FCGL	4.64E-08	5.20E-08	9.84E-08	3.42E-08	6.82E-08	1.02E-07
MMT	4.92E-08	5.52E-08	1.04E-07	3.63E-08	7.24E-08	1.09E-07
MMN	3.61E-08	4.04E-08	7.65E-08	2.66E-08	5.31E-08	7.96E-08
MMJ	2.83E-08	3.17E-08	5.99E-08	2.08E-08	4.15E-08	6.23E-08
MML	4.75E-08	5.31E-08	1.01E-07	3.49E-08	6.97E-08	1.05E-07
MMY	3.18E-08	3.56E-08	6.74E-08	2.34E-08	4.67E-08	7.02E-08
QZD	4.62E-08	5.17E-08	9.79E-08	3.40E-08	6.78E-08	1.02E-07
QZM	8.65E-08	9.68E-08	1.83E-07	6.37E-08	1.27E-07	1.91E-07
QZB	6.35E-08	7.11E-08	1.35E-07	4.68E-08	9.33E-08	1.40E-07
XMZ	6.80E-08	7.62E-08	1.44E-07	5.01E-08	9.99E-08	1.50E-07
XML	5.70E-08	6.38E-08	1.21E-07	4.20E-08	8.37E-08	1.26E-07
YJS	2.84E-08	3.18E-08	6.02E-08	2.09E-08	4.17E-08	6.26E-08
YJL	7.93E-08	8.88E-08	1.68E-07	5.84E-08	1.17E-07	1.75E-07
ZJT	3.71E-08	4.16E-08	7.87E-08	2.73E-08	5.45E-08	8.19E-08
ZJB	3.55E-08	3.97E-08	7.52E-08	2.61E-08	5.21E-08	7.82E-08
ZJJ	1.43E-08	1.60E-08	3.03E-08	1.05E-08	2.10E-08	3.15E-08
ZZT	5.44E-08	6.09E-08	1.15E-07	4.00E-08	7.99E-08	1.20E-07
ZZB	1.08E-07	1.20E-07	2.28E-07	7.92E-08	1.58E-07	2.37E-07

ZZS	3.19E-07	3.57E-07	6.75E-07	2.35E-07	4.68E-07	7.03E-07
ZZZ	2.00E-08	2.24E-08	4.25E-08	1.48E-08	2.95E-08	4.42E-08
SWN	5.47E-08	6.13E-08	1.16E-07	4.03E-08	8.04E-08	1.21E-07
BHX	4.11E-08	4.60E-08	8.70E-08	3.02E-08	6.03E-08	9.06E-08
STB	3.29E-08	3.68E-08	6.97E-08	2.42E-08	4.83E-08	7.25E-08
JYD	5.04E-08	5.65E-08	1.07E-07	3.71E-08	7.41E-08	1.11E-07
GXQZZ	3.68E-08	4.12E-08	7.80E-08	2.71E-08	5.40E-08	8.11E-08
DGF	1.13E-08	1.27E-08	2.39E-08	8.32E-09	1.66E-08	2.49E-08
JMC	4.21E-08	4.72E-08	8.93E-08	3.10E-08	6.19E-08	9.29E-08
ZHG	4.39E-07	4.91E-07	9.30E-07	3.23E-07	6.45E-07	9.68E-07
ZSL	3.15E-07	3.52E-07	6.67E-07	2.32E-07	4.62E-07	6.94E-07
HZX	9.31E-08	1.04E-07	1.97E-07	6.86E-08	1.37E-07	2.05E-07
GZX	1.45E-08	1.63E-08	3.08E-08	1.07E-08	2.13E-08	3.20E-08
GZT	3.59E-08	4.02E-08	7.60E-08	2.64E-08	5.27E-08	7.91E-08
GZN	9.81E-08	1.10E-07	2.08E-07	7.22E-08	1.44E-07	2.16E-07
SZM	7.64E-08	8.56E-08	1.62E-07	5.63E-08	1.12E-07	1.69E-07
SZX	7.91E-08	8.85E-08	1.68E-07	5.82E-08	1.16E-07	1.74E-07
maximum	4.39E-07	4.91E-07	9.30E-07	3.23E-07	6.45E-07	9.68E-07
minimum	1.13E-08	1.27E-08	2.39E-08	8.32E-09	1.66E-08	2.49E-08
mean	8.04E-08	9.00E-08	1.70E-07	5.92E-08	1.18E-07	1.77E-07

B:The carcinogenic risk values (CR) of TDCIPP with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total CR	ingestion	Dermal contact	Total CR
CZX	9.79E-07	4.54E-07	1.43E-06	7.21E-07	1.44E-06	2.16E-06
FCGS	4.38E-07	6.46E-08	5.02E-07	3.22E-07	6.43E-07	9.66E-07
FCGL	6.43E-07	8.06E-08	7.23E-07	4.73E-07	9.44E-07	1.42E-06
MMT	7.40E-07	8.55E-08	8.26E-07	5.45E-07	1.09E-06	1.63E-06
MMN	3.67E-07	6.27E-08	4.30E-07	2.70E-07	5.39E-07	8.09E-07
MMJ	1.33E-07	4.91E-08	1.82E-07	9.81E-08	1.96E-07	2.94E-07
MML	6.78E-07	8.24E-08	7.61E-07	4.99E-07	9.96E-07	1.50E-06
MMY	2.22E-07	5.52E-08	2.77E-07	1.63E-07	3.26E-07	4.89E-07
QZD	3.53E-07	8.02E-08	4.33E-07	2.60E-07	5.18E-07	7.78E-07
QZM	1.06E-06	1.50E-07	1.21E-06	7.84E-07	1.56E-06	2.35E-06
QZB	3.15E-07	1.10E-07	4.25E-07	2.32E-07	4.62E-07	6.94E-07
XMZ	8.68E-07	1.18E-07	9.86E-07	6.39E-07	1.27E-06	1.91E-06
XML	1.08E-06	9.89E-08	1.18E-06	7.95E-07	1.59E-06	2.38E-06
YJS	7.10E-08	4.93E-08	1.20E-07	5.23E-08	1.04E-07	1.57E-07
YJL	1.01E-06	1.38E-07	1.15E-06	7.47E-07	1.49E-06	2.24E-06
ZJT	5.40E-07	6.44E-08	6.05E-07	3.98E-07	7.94E-07	1.19E-06
ZJB	7.32E-07	6.16E-08	7.93E-07	5.39E-07	1.08E-06	1.61E-06

ZJJ	3.19E-07	2.48E-08	3.44E-07	2.35E-07	4.69E-07	7.04E-07
ZZT	7.96E-07	9.44E-08	8.91E-07	5.86E-07	1.17E-06	1.76E-06
ZZB	6.09E-07	1.87E-07	7.96E-07	4.48E-07	8.95E-07	1.34E-06
ZZS	6.82E-07	5.53E-07	1.23E-06	5.02E-07	1.00E-06	1.50E-06
ZZZ	1.51E-07	3.48E-08	1.86E-07	1.11E-07	2.22E-07	3.34E-07
SWN	8.75E-07	9.49E-08	9.70E-07	6.44E-07	1.29E-06	1.93E-06
BHX	1.29E-07	7.13E-08	2.00E-07	9.48E-08	1.89E-07	2.84E-07
STB	5.27E-07	5.71E-08	5.84E-07	3.88E-07	7.75E-07	1.16E-06
JYD	8.47E-07	8.75E-08	9.35E-07	6.24E-07	1.24E-06	1.87E-06
GXQZZ	7.33E-07	6.38E-08	7.97E-07	5.40E-07	1.08E-06	1.62E-06
DGF	1.31E-07	1.96E-08	1.51E-07	9.64E-08	1.92E-07	2.89E-07
JMC	5.37E-07	7.31E-08	6.10E-07	3.95E-07	7.89E-07	1.18E-06
ZHG	6.91E-07	7.62E-07	1.45E-06	5.09E-07	1.02E-06	1.52E-06
ZSL	1.02E-06	5.46E-07	1.56E-06	7.50E-07	1.50E-06	2.25E-06
HZX	7.36E-07	1.62E-07	8.98E-07	5.42E-07	1.08E-06	1.62E-06
GZX	4.67E-07	2.52E-08	4.92E-07	3.44E-07	6.86E-07	1.03E-06
GZT	5.29E-07	6.23E-08	5.91E-07	3.89E-07	7.77E-07	1.17E-06
GZN	8.58E-07	1.70E-07	1.03E-06	6.32E-07	1.26E-06	1.89E-06
SZM	8.74E-07	1.33E-07	1.01E-06	6.43E-07	1.28E-06	1.93E-06
SZX	8.82E-07	1.37E-07	1.02E-06	6.50E-07	1.30E-06	1.95E-06
maximum	1.08E-06	7.62E-07	1.56E-06	7.95E-07	1.59E-06	2.38E-06
minimum	7.10E-08	1.96E-08	1.20E-07	5.23E-08	1.04E-07	1.57E-07
mean	6.12E-07	1.40E-07	7.51E-07	4.50E-07	8.99E-07	1.35E-06

C: The carcinogenic risk values (CR) of ΣOPE with two pathways in soils

Sampling location	**children**			**adult**		
	ingestion	Dermal contact	Total CR	ingestion	Dermal contact	Total CR
CZX	1.24E-06	7.47E-07	1.99E-06	9.14E-07	1.82E-06	2.74E-06
FCGS	4.75E-07	1.06E-07	5.81E-07	3.50E-07	6.98E-07	1.05E-06
FCGL	6.89E-07	1.33E-07	8.22E-07	5.08E-07	1.01E-06	1.52E-06
MMT	7.90E-07	1.41E-07	9.30E-07	5.82E-07	1.16E-06	1.74E-06
MMN	4.03E-07	1.03E-07	5.06E-07	2.97E-07	5.92E-07	8.89E-07
MMJ	1.61E-07	8.07E-08	2.42E-07	1.19E-07	2.37E-07	3.56E-07
MML	7.26E-07	1.36E-07	8.61E-07	5.34E-07	1.07E-06	1.60E-06
MMY	2.54E-07	9.08E-08	3.44E-07	1.87E-07	3.73E-07	5.59E-07
QZD	3.99E-07	1.32E-07	5.31E-07	2.94E-07	5.86E-07	8.80E-07
QZM	1.15E-06	2.47E-07	1.40E-06	8.48E-07	1.69E-06	2.54E-06
QZB	3.78E-07	1.81E-07	5.60E-07	2.79E-07	5.56E-07	8.34E-07
XMZ	9.36E-07	1.94E-07	1.13E-06	6.89E-07	1.37E-06	2.06E-06
XML	1.14E-06	1.63E-07	1.30E-06	8.37E-07	1.67E-06	2.51E-06
YJS	9.94E-08	8.11E-08	1.80E-07	7.32E-08	1.46E-07	2.19E-07
YJL	1.09E-06	2.26E-07	1.32E-06	8.06E-07	1.61E-06	2.41E-06

ZJT	5.78E-07	1.06E-07	6.84E-07	4.25E-07	8.49E-07	1.27E-06
ZJB	7.67E-07	1.01E-07	8.68E-07	5.65E-07	1.13E-06	1.69E-06
ZJJ	3.33E-07	4.08E-08	3.74E-07	2.45E-07	4.90E-07	7.35E-07
ZZT	8.51E-07	1.55E-07	1.01E-06	6.26E-07	1.25E-06	1.88E-06
ZZB	7.16E-07	3.07E-07	1.02E-06	5.28E-07	1.05E-06	1.58E-06
ZZS	1.00E-06	9.10E-07	1.91E-06	7.37E-07	1.47E-06	2.21E-06
ZZZ	1.71E-07	5.72E-08	2.29E-07	1.26E-07	2.52E-07	3.78E-07
SWN	9.30E-07	1.56E-07	1.09E-06	6.85E-07	1.37E-06	2.05E-06
BHX	1.70E-07	1.17E-07	2.87E-07	1.25E-07	2.49E-07	3.75E-07
STB	5.60E-07	9.39E-08	6.54E-07	4.12E-07	8.23E-07	1.24E-06
JYD	8.98E-07	1.44E-07	1.04E-06	6.61E-07	1.32E-06	1.98E-06
GXQZZ	7.70E-07	1.05E-07	8.75E-07	5.67E-07	1.13E-06	1.70E-06
DGF	1.42E-07	3.23E-08	1.74E-07	1.05E-07	2.09E-07	3.14E-07
JMC	5.79E-07	1.20E-07	6.99E-07	4.26E-07	8.51E-07	1.28E-06
ZHG	1.13E-06	1.25E-06	2.38E-06	8.32E-07	1.66E-06	2.49E-06
ZSL	1.33E-06	8.99E-07	2.23E-06	9.82E-07	1.96E-06	2.94E-06
HZX	8.29E-07	2.66E-07	1.10E-06	6.11E-07	1.22E-06	1.83E-06
GZX	4.82E-07	4.15E-08	5.23E-07	3.55E-07	7.08E-07	1.06E-06
GZT	5.65E-07	1.02E-07	6.67E-07	4.16E-07	8.30E-07	1.25E-06
GZN	9.56E-07	2.80E-07	1.24E-06	7.04E-07	1.41E-06	2.11E-06
SZM	9.50E-07	2.18E-07	1.17E-06	7.00E-07	1.40E-06	2.10E-06
SZX	9.61E-07	2.26E-07	1.19E-06	7.08E-07	1.41E-06	2.12E-06
maximum	1.52E-06	1.25E-06	2.38E-06	1.12E-06	2.23E-06	2.94E-06
minimum	8.23E-08	3.23E-08	1.74E-07	6.06E-08	1.21E-07	2.19E-07
mean	6.92E-07	2.30E-07	9.22E-07	5.10E-07	1.02E-06	1.53E-06

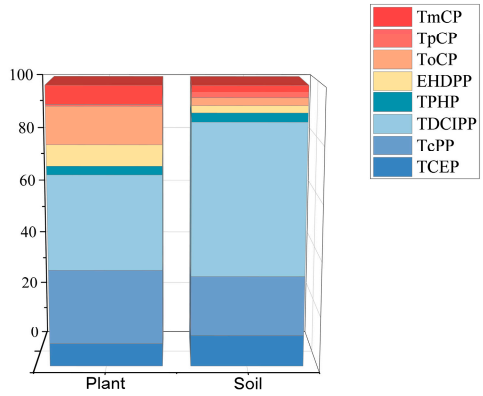

Figure S1. Contribution degree of each OPE monomer in soil and plants

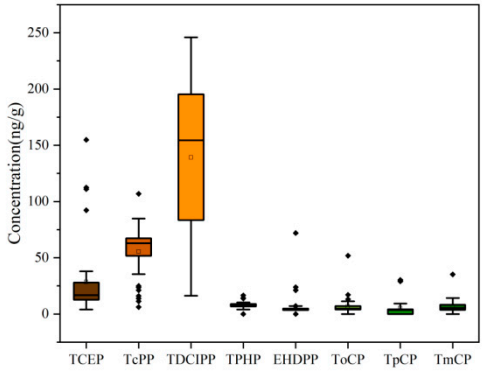

Figure S2 Concentration of each OPE in the soil

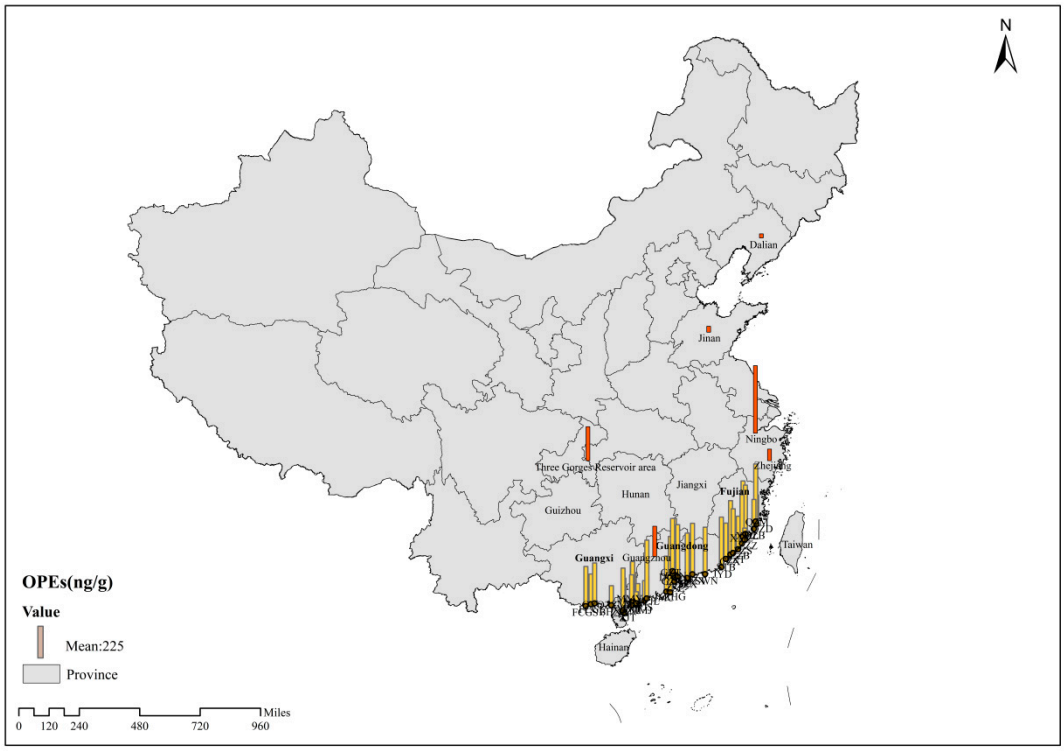

Figure S3 Concentration and geographical distribution of OPEs in soils in coastal areas of South China and other studied regions. The concentration of OPEs in Other studied regions (red column); The concentration of OPEs in this study (yellow column).

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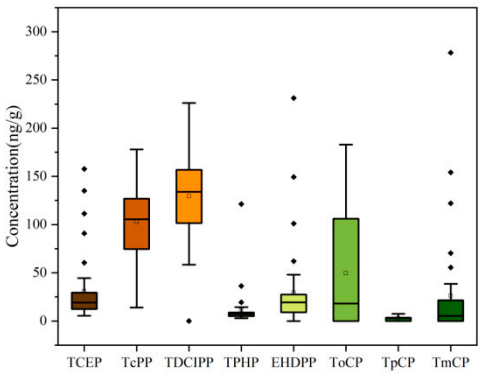

Figure S4 Concentration of each OPE in the plant

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